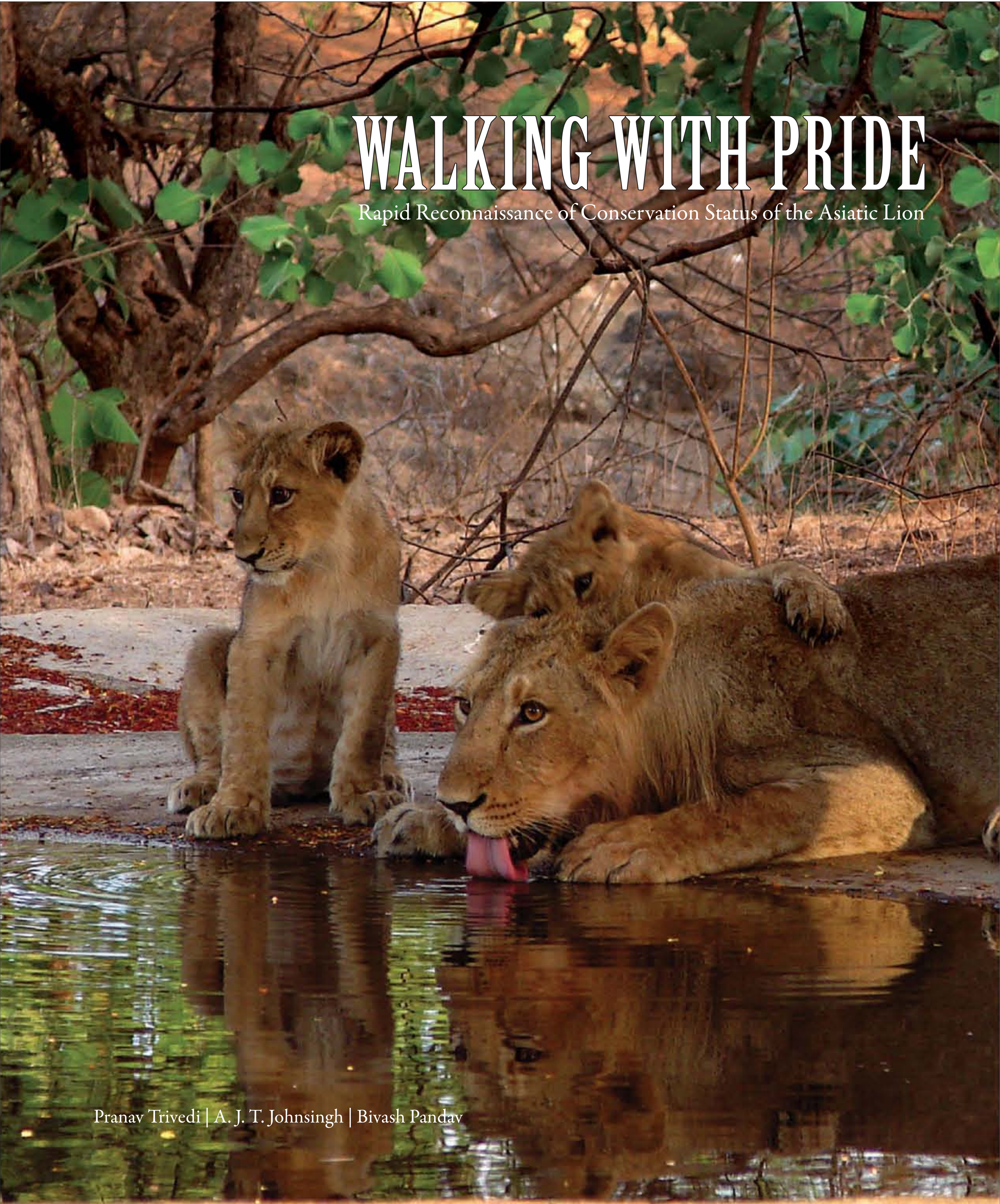

WALKING WITH PRIDE

Rapid Reconnaissance of Conservation Status of the Asiatic Lion

Pranav Trivedi | A. J. T. Johnsingh | Bivash Pandav

Nature Conservation Foundation
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SUMMARY

Introduction: The endangered Asiatic Lion *Panthera leo persica* – a flagship species synonymous with the Gir forest and Gujarat, faces a multitude of existing and potential threats including disease outbreak, poaching and conflict with local herders and agriculturists in its present home comprising of the Gir National Park (NP) and Wildlife Sanctuary. The Gir PA - an intact forest and savanna tract of about 1,500 km^2 is of utmost importance for the long-term conservation of this subspecies. No assessment of the conservation status of the lion has been undertaken after recent incidences of poaching followed by preventive action of the State Forest Department. Besides, absence of a mechanism for regular (annual) and sustained, long-term monitoring of the lion population, its prey and their habitat is a major gap in lion conservation. Hence, we used a rapid assessment method by traversing the length of the Gir PA on foot while recording sightings and indirect evidences of lion, other large carnivores and their prey. Informal interviews, discussions and observations of the forest department field staff and local community members as well as various management practices and anthropogenic activities were also made to aid in the assessment. We used a continuous foot transect across the length of Gir PA to collect this data. The survey route (foot transect) beginning from Pipalwa and ending at Sasan spanned a length of about 110 km, a distance that was walked in seven days. We walked for 23 km inside the NP and 67 km inside the Sanctuary, while a 20 km stretch was along the southern edge of NP and Sanctuary. Of the total 12 ranges within Gir PA, our route passed through six.

The rapid reconnaissance aimed at assessing the conservation status of the lion in Gir PA through:

1. Collection of first hand data on the presence and abundance (direct & indirect means) of lion, other large carnivores, their ungulate prey species and the habitat of Gir PA.
2. Submission of a technical report on the conservation status of the lion to aid in better implementation of conservation practices.
3. Disseminating the information gathered through articles in popular and scientific fora.

Results: We recorded 17 species of terrestrial mammals through a total of 636 detections (sightings and signs) during the reconnaissance. These included seven species of carnivores, eight medium to large prey species of the lion, which included six ungulate species and two lesser mammals. Domestic livestock (buffaloes and cattle) was also recorded during the survey. Overall mammal encounter rate was 5.8/km for the Gir PA. A total of 592 detections entailing 215 (7 sightings and 208 signs/indirect evidences) of large carnivores (lion, leopard, hyena, jungle cat and jackal) and 377 of large wild and domestic prey species (112 sightings and 265 signs) were obtained. This yielded an overall encounter rate of 1.95/km for carnivores and 3.33/km for larger prey species. Among the carnivores, the highest detections were for lion followed by leopard, jungle cat, hyena and jackal. Six sightings consisting of eight lions (six adult males and two adult females) were obtained. Of these, four lions each were sighted in East Gir and West Gir. We recorded lion calls on three occasions, of which one was a pride (consisting of about seven

animals - lionesses and sub-adults). Pooling the data of both, sightings and calls, the number of lions was 17 in nine detections yielding an average group size of 1.9. Of the 123 lion scats recorded, the highest were in the Sanctuary area (42.3 %, encounter rate 0.78/km), followed by the area along the edge between NP and Sanctuary (39 %, encounter rate 2.4/km) and NP (18.7 %, encounter rate 1/km). East Gir yielded 29 scats (23.6 %) and 94 scats (76.4 %) were found in West Gir. The overall scat encounter rate was 1.1/km. Of the 123 scats, nearly half were fresh (47.2 %) and old (45.5 %) respectively. The highest number of scats were found on Janwadla to Kamleshwar route in West Gir (n=47, scat encounter rate of 2.04/km), accounting for over one third (38.2 %) of the total scats found. A low number of scats (14 scats in 30 km, encounter rate of 0.47/km) were encountered on the Chhodavdi-Jamwala and Bhimchas-Hadala routes. Total detections of leopard were a little over one fourth of lion detections. The encounter rate of leopard scats was 0.2/km. Scat encounter rate of jungle cat was 0.1/km. Very low number of hyena scat and tracks were encountered.

The day wise encounter indicated very high movement and use of Jamwala-Janwadla-Kamleshwar region by lions in Gir PA. High use of the NP- Sanctuary edge in this region was noteworthy and probably indicated several overlapping home ranges or some other habitat-based or prey-based (possibly both) advantages. This also highlights the importance of the NP in conservation of lions. The low scat encounter rate on the fourth day could be largely owing to walking on smaller forest trails and the State Highway that has high vehicular traffic and disturbance. West Gir showed three times higher number of scats. However, when scat encounter rates for East Gir and West Gir (0.7/km and 1.4/km respectively) were considered, West Gir showed double the rate of scat encounter than East Gir. This could partly be due to less coverage of roads and higher use of smaller trails in the hilly, interior forest areas in East Gir. Low detection of leopard was attributable to higher portion of the transect passing along roads than trails, which are used by lion – the more powerful of the two predators of Gir. Very low encounter of hyena and jackal throughout the survey could be due to pesticide poisoning and/or road kills though for the former low defecation rates cannot be ruled out. With only one sighting of vultures, this possible low detection of both avian and mammalian scavengers of Gir ecosystem should be a cause of concern and worth investigating.

Based on sightings, chital had the highest encounter rate of 0.7/km followed by common langur (0.1/km), sambar (0.1/km), nilgai (0.05/km), livestock (0.03/km), wild pig (0.01/km) and chinkara (0.01/km). No sightings of chousinga were obtained on the foot transect. When indirect evidences were compared, sambar showed highest encounter followed by nilgai, chital, chinkara, chousinga, wild pig, buffalo and common langur. Chital showed the highest relative abundance of 60.3 percent, but with one major change being that livestock (buffaloes) contributed highly (22 %) in terms of relative abundance. Encounter rates for all detections (sightings and signs combined) were the highest (4.7/km each) on days four and five in and around the NP followed by days six and three (3.5/km and 3.2/km respectively) and day two (3/km). The lowest encounter rates of 2.3/km and 2.4/km were on days one and seven respectively. On the days that we walked in and around the NP yielded higher number of occurrences. Chital and nilgai were truly representative prey species being detected on all the seven days of the walk and available to lion and leopard in all parts of Gir PA. Porcupine was encountered throughout the PA with a majority of its detections (40.5 %) being obtained on day 3 on the Hadala-Chhodavdi trail. The encounter rate of its droppings was 0.34/km. The other lesser mammals showed very low encounter rates. Chital, common langur and wild pig were detected more frequently by sightings than sambar, nilgai, chousinga and chinkara which were better recorded by droppings/pellet groups. Highest detections of prey species also corresponded to the highest number of lion scats, especially for Janwadla-Kamleshwar route. It seems that high wild prey availability, especially sambar could have given rise to higher detection of lion scats here. Chital, nilgai and common langur were encountered more or less throughout on the foot transect; while sambar, chousinga, chinkara and wild pig showed patchy patterns of encounter. Sambar and chousinga appeared partial to hilly and less disturbed tracts compared to chital and nilgai which were encountered almost throughout, barring the seventh day. Chinkara sightings and signs were found only in East Gir, an area of savanna, thorn-scrub and grassland, where nilgai presence was also higher. The lowest encounter of wild prey was in the tourism zone (Sasan to Kamleshwar). Domestic livestock had a low encounter, but owing to high numbers and biomass, it occupies a position only next to that of chital in terms of prey availability for the lion. Gir PA is a stronghold of several species of threatened lesser mammals such as the rusty-spotted cat, ratel and Indian pangolin. Occurrence of ratel in various parts of Gir was confirmed through the present survey.

Good habitat quality in Gir was reflected through copious regeneration of major tree species, luxuriant riverine vegetation along all the major river courses (except some stretches along the Hiran river in the tourism zone), low (or no) weed infestation, near absence of illicit tree cutting, protection of habitat through patrolling and various other management practices and abundance of wild ungulates. High occurrence of plant species such as *F. bengalensis*, *Z. mauritiana* and *C. carandus* play key roles by providing important habitat requirements of lions and other wildlife. The practice of controlled extraction of grass for fodder seems to be very useful for habitat management as very dense and tall grass is unpalatable for wildlife, creates fire hazard and prevents fresh growth. Livestock grazing at the present extent has not caused competition induced changes in the dominant wild prey – chital’s population. Occurrence of chital and other wild prey in fair abundance coupled with their low flight distances is a reiteration of the health of habitat in terms of good forage availability and lack of persecution from humans. The present extent of fuel wood removal by *maldharis* and people of neighbouring villages needs to be quantified and monitored for preventing commercial use of this resource.

Management interventions such as fire prevention/controlled burning, waterhole management and soil-moisture conservation activities (check dam construction) are showing positive impact through improving habitat quality and preventing degradation. By placing waterholes within or besides existing water courses and spacing these out evenly, crowding of herbivores and subsequent degradation of the surrounding habitat will be prevented. Patrolling of the PA and surrounding areas is crucial for protection after the trapping and poaching incidents in 2005 and 2007 which resulted in casualties of lions in Gir PA. Whereas the role and impact of mobile squads is clear and important, day-time patrolling by guards is even more crucial as changes in habitat and wildlife vis a vis human activities can only be detected and reported better through this intervention. A special cadre of informers (who are preferably local community members) could be created who move in the villages to gather evidence and information about illegal activities concerning wildlife. Harnessing both, the experience and knack of the senior guards and the energy and enthusiasm of the fresh recruits as well as regular assessment by the higher authorities of the Gir PA could help achieve this in a more effective manner.

High occurrence of lions and their prey along the NP - Sanctuary edge and in NP area as shown by scat encounter rates during this survey dispels the issue of unsuitability of the NP for the lion due to dense habitat. Besides, several reports of the past clearly mention Gir as a dense/thick forest, where lions have shown a consistent and encouraging increase in population over the last four decades. Long stretches of rivers *Ardak*, *Bhuvatirth, Shingavda* and *Dhatardi* within the NP have pristine gallery forests that provide shade and shelter to the lions and wild ungulates during the hot days/summer. Owing to healthy habitat conditions, a high proportion of all the wild prey species of lion (except chinkara) was recorded in the NP. Moderate to high abundance of sambar and chital in Chhodavdi and Jamwala ranges reflects excellent habitat conditions for lion and leopard. Invasion of the exotic *Lantana camara* has also been controlled effectively and regular removal has helped prevent further damage to the habitat. All the above factors coupled with a near lack of human impacts make the NP an undisturbed stretch of quality habitat for lion and its prey.

Based on the informal discussions with and observations of the forest department field staff and *maldharis*, we submit that there is a need to -

- Motivate the guards by organizing refresher courses, where they are inspired with stories of guards having achieved amazing feats in other PAs of India. This can also be done by study tours and/or screening of films during the motivation workshops.
- Award the guards/foresters who have made commendable efforts in protection and preventing poaching/degradation etc.
- Facilitate interaction and learning between old and new field staff by organizing pair/team patrolling at least once/twice a month, field skill workshops. This will help the old in increasing self-esteem and pride, while for new staff it will be valuable learning.
- Promote interaction with good naturalists and facilitate nature interpretation and observation skills.
- Facilitate greater positive and synergistic interaction within the field staff and between them and higher officials. This will aid in facilitating improvement of their self-image, leadership and teamwork and making them stake-holders.
- Promote periodic visits of higher officers for grievance redressal, encouragement and being familiar with field problems.
- Provide hygienic living conditions and healthcare for them and their families.

- There is very little involvement of the *maldhari* populace in protection and management of the PA. A larger stake in protecting and improving the habitat and soliciting voluntary involvement could be of relevance in the long-term.
- Awareness generation among students is being carried out through nature education camps, however, greater involvement of rural youth in protection and monitoring as well as eco-tourism will help in conserving Gir for posterity.

The following suggestions based on the present reconnaissance could be useful as guidelines –

- Our method of using foot transect across the length of Gir PA was effective in yielding baseline for regular implementation of such a monitoring exercise.
- Using the same transect for lion and its prey species will be very useful and using roads for this purpose will be advisable.
- It is clear that for carnivores, scat was a useful indicator of their occurrence and abundance; while for the prey species, direct sightings were more useful. Sightings of carnivores and dung/pellet group encounter rate methods for these can be used respectively in addition.
- Lion monitoring by scat-encounter could be preceded by removal of all old scats on day-1 and then survey should be made on day-8 after leaving a gap from day-2 to day-7. This will help ensure that only freshly deposited scat is considered and double counting is avoided. This can yield an index of lion abundance that would help in comparing habitat use by lions between different regions of Gir PA.
- Two routes running parallel across northern and southern portions could be used for this purpose. About 200 to 250 km would be covered in this monitoring.
- The status and health of habitat in Gir PA is good and management activities were implemented properly and effectively.
- Regular patrolling, photo monitoring by guards could help lion conservation in a tremendous way. The Gir Welfare Fund (GWF) can bring out a quarterly newsletter/annual souvenir, where observations of field staff are published.
- As the ‘tourism zone’ in Sasan-Kamleshwar zone showed the lowest encounter rates of ungulates and lion detection; but higher signs of disturbance including weed infestation and riverine habitat degradation; this zone could be monitored to assess the impacts of tourism. On the other hand, one of the routes could be rested for a year or two from the tourist circuits on a rotational basis to allow its recuperation.
- The state highways in PA with a high number of vehicles were found to be a detrimental to wildlife. Hence, it is important to curb night traffic on all the roads passing through Gir PA in the light of high conservation status and priority accorded to the lion.

It is clear from the foregoing that the habitat status and health is good in Gir PA supporting high prey species diversity for carnivores. Adequate management interventions are being carried out to safeguard the lion and its habitat. Results of scat detection also support our view that the lion’s conservation status is good in Gir PA.

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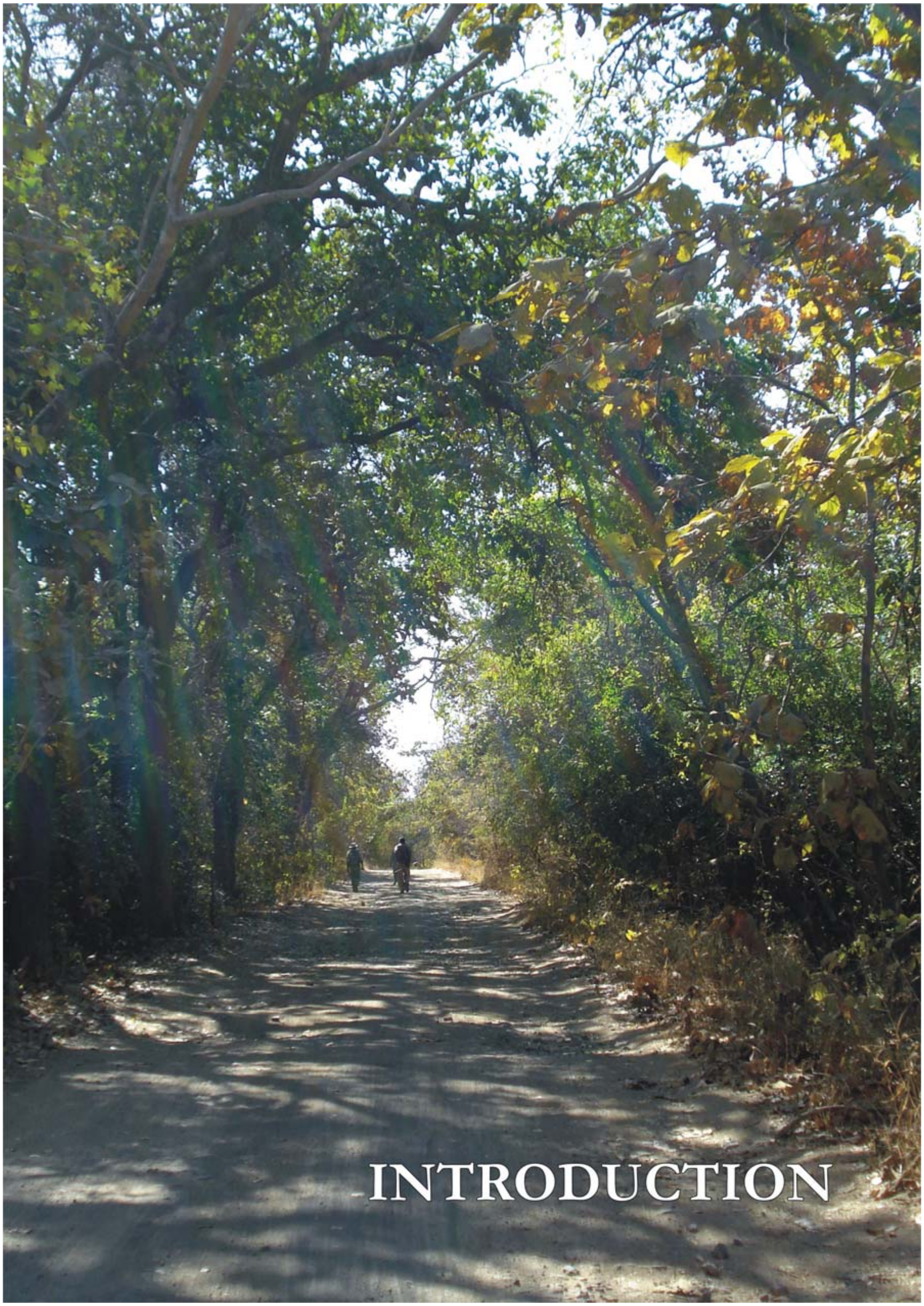


INTRODUCTION

Background

The last free-ranging population of the endangered Asiatic Lion *Panthera leo persica* occurs in the Gir National Park (NP) and Wildlife Sanctuary (Gir PA) along with few small, satellite populations found in the adjacent region comprising about 1,883 km^2 area (Johnsingh *et al*. 2007, Singh 2007). With an estimated global population of 359 animals in its natural habitat (Gir PA and satellite populations in Girnar and Mitiyala Sanctuaries, coastal belt, Hippavadlee and Babra *vidi*) as per the last census of 2005, this critically endangered large cat faces a multitude of existing and potential threats including disease outbreak, poaching and conflict with local herders and agriculturists in its present home (Johnsingh *et al*. 2007). Having experienced a major genetic bottlenecking episode in the historical past (O'Brien *et al*. 2003) and an upsurge of poaching in the recent past when eight lions were killed (Singh 2007) presumably for trade in body parts, the Asiatic Lion's vulnerability has only been made more apparent. An earlier abortive attempt to translocate lions to Uttar Pradesh (Negi 1969 in Divyabhanusinh 2008) and the unresolved issues concerning a second translocation to Madhya Pradesh threaten this single population. Attitudes of local people living in and around Gir towards the lion range from hostile and negative to positive and supportive (Saberwal *et al*. 1994, Ravi Chellam 1997 in Divyabhanusinh 2008, Singh 2007, *pers. observation*), but casualties of the lions as well as humans indicate that proportionately the toll on the former is much more serious. However, after the recent poaching instances (in 2005 and 2007), the Gujarat State Forest Department has taken several important steps to halt poaching and prevent factors inimical to conservation in Gir. A major initiative in this direction included recruitment of forest guards, their training and procurement of motorbikes for field staff.

Due to protection provided through a complete ban on shooting and declaration of Gir Wildlife Sanctuary in 1965 and its proper management; the lion population has shown a steady increase (Singh 2007). Subsequently, this rise in population has also led to dispersal of lions to surrounding landscape that is largely agricultural and dotted with human settlements. Although the Government of Gujarat has responded by declaring additional wildlife Sanctuaries in this region and creating infrastructure to respond to conflicts and crisis, existing evidence indicates that the animals living on the periphery of Gir PA as well as those occurring as the satellite populations will face more conflict compared to the source population in Gir PA (Saberwal *et al*. 1994, Singh 2007). Hence, the source population in Gir PA inhabiting an intact forest and savanna tract of about 1,500 km^2 is of utmost importance for the long-term conservation of this subspecies.

Context of the Survey

Several research projects on the ecology and behavior of lions have been conducted during the past four decades at Gir PA (see Sharma and Johnsingh 1996). At present, a five-yearly census is the predominant method of monitoring lion population. Absence of a mechanism for regular (annual) and long-term monitoring of the lion population and their conservation status is a major gap in lion conservation. Lion being the flagship species for Gir, it is imperative to carry out long-term monitoring of their population (Jhala *et al*. 2004). Earlier, Joslin (1984) had attempted the pugmark and scat encounter methods to arrive at population figures and suggested their usefulness for monitoring lions in Gir PA. Recently, Jhala *et al*. (2004) suggested the use of vibrissae pattern and radio telemetry techniques for long-term monitoring of lions. Both these methods, though tested and useful, depend on actual encounter and observations of individual lions and can be time-consuming, expensive and require skilled personnel to do it. These methods emphasize estimating the actual population, however, changes over time in number of scats and pugmarks of lions detected along roads are alternate, easier ways to determine trends of change in lion population (Joslin 1984). A method that is simple to follow, cost-effective, does not depend on sighting of lions, yet fairly reliable and can be repeated at fixed intervals may prove to be more useful in monitoring the lion population at Gir PA. The scat-encounter method we used during the present survey fits the above requirements well and has also been tried out and tested by Joslin (1984). Here, we discuss the results of the present reconnaissance conducted to assess the conservation status of lion and recommend it as a potential low-cost method for the regular monitoring of lion and other large carnivores as well as prey species through involvement of the forest department field staff possessing basic field skills. Our work also provides a baseline for future work in this direction.

Aim and Objectives

The present rapid survey was aimed at assessing the conservation status of the Asiatic Lion in Gir PA to facilitate better conservation planning. The specific objectives of the proposed reconnaissance were:

1. Collect first hand data on the presence and abundance (through direct and indirect means) of Asiatic Lion, other large carnivores, their ungulate prey species and the habitat of Gir.
2. Prepare and submit a technical report on the conservation status of the lion to aid in better implementation of conservation practices.
3. Widely publish the information gathered through articles in popular and scientific fora.

Starting the transect in East Gir

Asiatic Lion *Panthera leo persica* in its natural habitat at Gir PA

METHODS

Sampling

Rapid reconnaissance is a widely used non-intrusive method for wildlife surveys (see Rodgers 1990). The Asiatic Lion *Panthera leo persica* is a large cat occurring in groups making it suitable for this method to assess its conservation status. Hence, we explored the potential of this rapid assessment method by traversing the length of the Gir PA on foot while recording sightings and indirect evidences of lion, other large carnivores and their prey. Along side, we also documented habitat health and various anthropogenic factors in terms of human activities within the PA and morale/attitudes of the Forest Department (field) staff towards their job and lion conservation. To achieve this, we used a continuous foot transect (about 110 km walked in seven days) across the length of Gir PA. Informal interviews of the field staff and local community members as well as observations on various management practices and anthropogenic activities were also made to aid in the assessment. We treated the entire walk on existing roads/trails as a foot transect. During the walk, the following data was recorded:

1. Sightings and numbers of lion, other large carnivores and ungulate prey with details of age/sex classes (when possible)
2. Indirect evidences of all target species (pugmarks, scats, dung, scrapes, calls etc.)
3. Human presence/activities including livestock grazing/signs, tree cutting, collection of forest produce, management activities etc.
4. Visual assessment of the status and health of vegetation
5. Informal discussions (structured/spontaneous) with the forest department field staff and local people
6. Any other relevant aspects (e.g. behaviour of wildlife, any unusual/interesting observations)

For lion, other carnivores and their ungulate prey species, encounter rates were obtained by dividing the number of sightings/individuals by the distance walked. Visual estimation of habitat health using parameters of presence/absence/extent of disturbance (cutting, lopping, biomass removal and weed proliferation) was made. Photographic documentation of the habitat was also carried out during the survey. The skills of local guides and forest guards were used extensively to increase detections and validate the identity of species based on tracks and droppings. For lion scat identification, the criteria of diameter greater than 4.5 cm experimentally derived by Joslin (1984) and our own field experience as well as that of the senior forest guards was used. Lion scats were classified as ‘fresh’, ‘old’ and ‘very old’ depending on the coloration and consistency of scats. Greenish to black and dark grey, intact scats were treated as ‘fresh’; those with dull greyish colour and signs of disintegration as ‘old’ and grey to whitish disintegrated scats as ‘very old’. Transects were walked by a team of three to seven people with the exception of day one when the team consisted of twelve members.

Survey Route

The survey route (foot transect, see Table 1) beginning from Pipalwa and ending at Sasan spanned a length of about 110 km (Figure 1), a distance that was walked in seven days. Transects were walked between 7:15 hrs to 12:30 hrs and 14:30 (sometimes 15:00) to 18:30 hrs. We walked for 23 km inside the NP and 67 km inside the Sanctuary, while a 20 km stretch was along the southern edge of NP abutting the Sanctuary. Of the total 12 ranges within Gir PA, our route passed through six (Tulsishyam and Bhimchas in East Gir and Chhodavdi, Jamwala, Ankolwadi and Sasan in West Gir).

Table 1. Route details for survey of lion conservation status in Gir PA

Day	**Route**	**Approximate distance (km)**	**Forest range(s)**
08-02-2009	Pipalwa to Bhimchas	16	Tulsishyam, Bhimchas
09-02-2009	Bhimchas to Hadala	13	Bhimchas
10-02-2009	Hadala to Chhodavdi	23	Bhimchas, Chhodavdi
11-02-2009	Chhodavdi to Jamwala (dam)	17	Chhodavdi, Jamwala
12-02-2009	Batheshwar to Janwadla	8	Jamwala
13-02-2009	Janwadla to Kamleshwar dam	23	Ankolwadi
14-02-2009	Kamleshwar to Sasan	10	Sasan, Ankolwadi

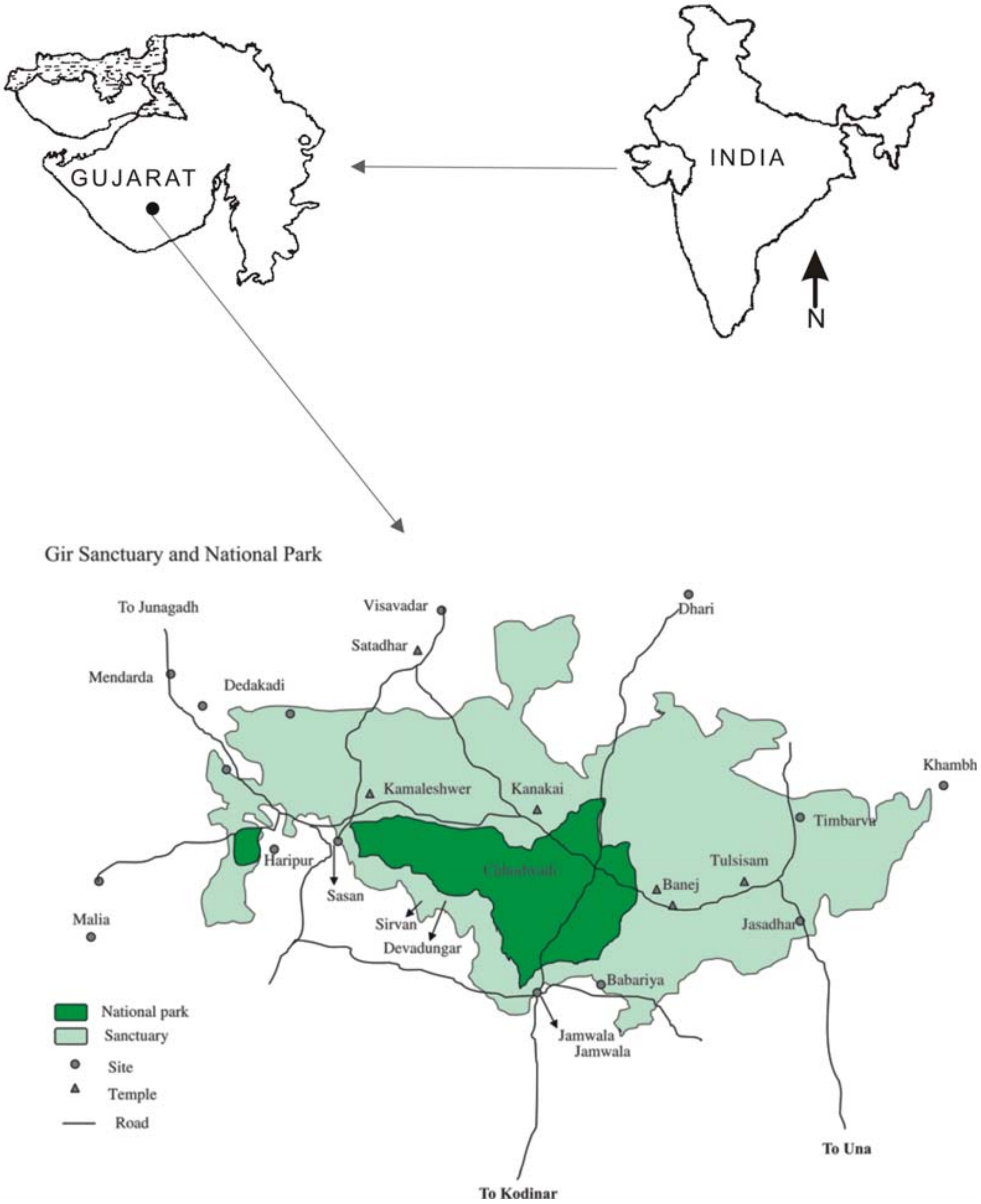
Different signs used for indirect detection of mammals

Interaction with local pastoralists, *the maldharis*

STUDY AREA

Gir National Park and Sanctuary (collectively called Gir PA), one of the largest contiguous forested tracts in peninsular India comprises of 1,412 km^2 of which the former covers 259 km^2 and the latter 1,153 km^2. It lies between 20^o 55’ N and 21^o 20’ N and 70^o 25’ E and 71^o 15’ E in Junagadh District in the Saurashtra peninsula of Gujarat state, India (see Figure 1)

Figure 1. Location of Gir N. P. and Sanctuary



Characterized by a tropical monsoonal climate, Gir has three distinct seasons viz. winter (November to February), summer (April to June) and monsoon (July September) with months of March and October being transitions. Annual rainfall ranges from 600 mm in the eastern parts to about 1,000 mm in the western portion of the PA with an average annual rainfall for the entire PA being 800 mm (Sharma and Johnsingh 1996). The terrain is hilly and undulating with the northern parts being more rugged. Altitude ranges from 100 m to 528 m ASL. Geologically, the area forms part of the Deccan Trap lava flows that characterise much of the central peninsular India. It forms the catchment of seven rivers (Sharma and Johnsingh 1996).

Clothed with dry deciduous forests dominated by *Tectona grandis, Wrightia tinctoria, Terminalia crenulata* and *Anogeissus latifolia*; thorn forests consisting of *Acacia* spp. and *Zizyphus mauritiana*; riverine or gallery forests with chief floral elements such as *Syzygium rubicunda*, *Pongamia glabra*, *Tamarindus indica*, *Mitragyna parviflora*, *Ficus bengalensis*, *Terminalia bellerica* and *Holoptelia integrifolia*; savanna; and scrubland habitats; Gir PA boasts of a rich diversity of flora and fauna consisting of over 3,000 species. Besides being the last abode of the endangered Asiatic Lion (*Panthera leo persica*), Gir possesses several globally threatened taxa of birds and mammals, and boasts of the largest population of marsh crocodile (*Crocodylus palustris*) in India. With about 38 species of mammals, over 300 species of birds, 37 species of reptiles, 2,000 species of invertebrates and nearly 500 species of plants (Singh 2001, Anon. 2005), Gir PA has global and national significance for biodiversity conservation. Detailed description of the study area is available in Trivedi (1993) and Sharma and Johnsingh (1996).

A rich cultural heritage in the form of local pastoralists (called *maldharis*) thrives in Gir. These *maldhari* communities reside in habitations called *ness*. At present, there are 54 *nesses* inside the Gir PA; some of these are evacuated by the inhabitants temporarily during the summer months, apparently owing to fodder scarcity (*pers. comm.*, *maldharis* of Dadhiya *ness*). Over 15,000 livestock heads belonging to the *maldhari* community and the inhabitants of 14 forest settlement villages graze inside the PA (Anon. 2005). Various management interventions at Gir PA include waterhole and road maintenance, fire line creation, soil and moisture conservation, capture and relocation of straying/problematic carnivores, treatment of injured animals and five-yearly census of major predators and prey. There is an extensive road network inside the PA with three State Highways. A 12-km stretch of railway line also passes through the western part of the Sanctuary. Each year, about 250,000 pilgrims visit the important pilgrimage sites of Kankai, Banej, Tulsishyam and Patla-mahadev located within the PA; while about 100,000 tourists visit the tourism zone in West Gir Division that covers about a tenth of the PA (Singh 2007).

Hilly savanna habitat in East Gir

Open habitat with good grass

The *maldhari* of Gir

Ness - a typical *maldhari* dwelling

RESULTS

Introduction

We recorded 17 species of terrestrial mammals through a total of 636 detections (sightings and signs) during the reconnaissance through direct sightings and/or evidences. These included seven species of carnivores including lion (*Panthera leo persica*), leopard (*P. pardus*), striped hyena (*Hyaena hyaena*), jungle cat (*Felis chaus*), golden jackal (*Canis aureus*), ratel or honey badger (*Mellivora capensis*) and small Indian civet (*Viverricula indica*); and eight medium to large prey species of the lion, which included six ungulate species – chital (*Axis axis*), nilgai (*Boselaphus tragocamelus*), sambar (*Cervus unicolor*), chinkara (*Gazella gazella*) and chousinga or four-horned antelope (*Tetracerus quadricornis*), and wild pig (*Sus scrofa*) besides common langur (*Semnopithecus entellus*) and Indian porcupine (*Hystrix indica*). The Indian pangolin (*Manis crassicaudata*) and black-naped hare (*Lepus nigricollis*) were detected through their signs. Domestic livestock (buffaloes and cattle) was also recorded during the survey. Overall mammal encounter rate was 5.8/km for the Gir PA. A total of 592 detections entailing 215 (7 sightings and 208 signs/indirect evidences) of large carnivores (lion, leopard, hyena, jungle cat and jackal) and 377 of large wild and domestic prey species (112 sightings and 265 signs) were obtained along the 110 km foot transect (Tables 2 & 3). This yielded an overall encounter (detection) rate of 1.95/km for carnivores and 3.33/km for larger prey species.

Carnivores

Among the carnivores, the highest detections were for lion (Table 2) followed by leopard, jungle cat, hyena and jackal. Of these, lion and jackal were sighted on foot transect; for the rest of carnivores only indirect evidence was obtained. Of the six sightings consisting of eight lions (six adult males and two adult females), one male was above 15 years of age; four belonged to 5-9 years category, while one lion was in 9-12 year age group. Incidentally the oldest male is a known individual (*pers. comm.* Suleimanbhai) and has ranged over much of West Gir Division. Of the two sightings consisting of a male and a female, one was a courting pair involving this old male; while the other pair (with both animals around five years of age, *pers. comm.* forest guards) appeared to be siblings.

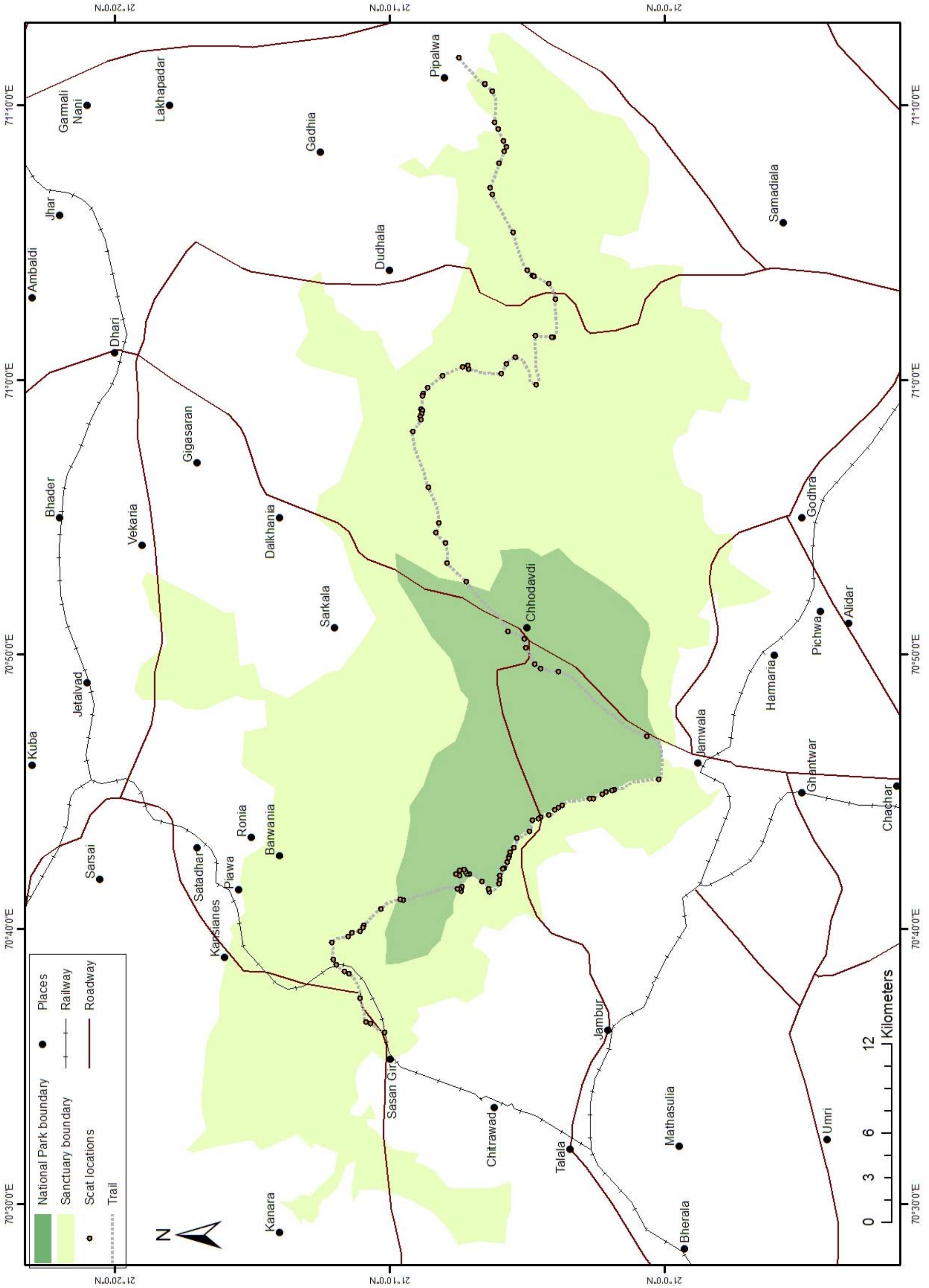
Table 2. Detections (frequencies) of carnivores in Gir PA: 8-14 February, 2009

	Calls	**Sightings**	**Scats**	**Scrapes**	**Tracks**	**Total**	**Detections (%)**
Lion	3	6	123	0	18	**150**	**69.8**
Leopard	0	0	21	6	15	**42**	**19.5**
Hyena	0	0	4	0	5	**9**	**4.2**
Jungle cat	0	0	12	0	0	**12**	**5.6**
Jackal	0	1	1	0	0	**2**	**0.9**
Total	**3**	**6**	**161**	**6**	**38**	**215**	**100**

Four lions each were sighted in East Gir and West Gir. The lions sighted in east Gir were quick to retreat while those sighted in West Gir allowed closer approach (including the courting pair) and appeared confiding. We recorded lion calls on three occasions, of which one was a pride (consisting of about seven animals - lionesses and sub-adults) involved in a hunting attempt near *Asundrali ness*, while two others were of single males calling. These were separate animals from those included under sightings. Pooling the data of sightings and calls, the number of lions was 17 in nine detections yielding an average group size of 1.9 lions; considering only sightings the group size was 1.3. We sighted a pair of jackals near Hadala forest quarters on the second day. Other carnivore sightings occurred opportunistically on vehicular drives (in jeep) while moving to/back from our transect points to the rest houses. During these drives, we sighted leopards on three occasions and hyena once. All instances involved single animals.

Indirect evidence of carnivores was recorded in the form of scats, tracks, calls and scrapes. Of the 123 lion scats recorded on the transect (Figure 2), 52 (42.3 %, encounter rate 0.78/km) were in the Sanctuary area, 23 (18.7 %, encounter rate 1/km) within the National park and 48 (39 %, encounter rate 2.4/km) were along the edge between the two conservation units (Figure 2). The overall scat encounter rate was 1.1/km. East Gir yielded 29 scats (23.6 %) and 94 scats (76.4 %) were found in West Gir. Of the 123 scats, 58 (47.2 %) were fresh, 56 (45.5 %) old and 9 (7.3 %) very old. On several occasions, we observed more than two fresh scats within a distance of 25 to 50 m indicating that the scats belonged to male coalitions or prides with two or more animals.

Figure 2. Scat locations (GPS) of lion at Gir PA: 8-14 February, 2009



Out of the 123 scats encountered, day wise encounter chart (Figure 3) showed that the highest number of scats (n=47, scat encounter rate of 2.04/km) were found on day-6. This stretch of Janwadla to Kamleshwar (passing through NP, Sanctuary and along their edge) route in West Gir accounted for over one third of the scats (38.2 %) found. This together with the Jamwala (Batheshwar) – Janwadla stretch of road (24 scats, scat encounter rate - 3/km) yielded 71 scats (57.7 %, overall scat encounter rate 2.29/km), of which fresh scats (n=31) comprised more than half (53.4 %) of the total fresh scats found on the entire transect. The lowest number of scats were encountered on the fourth day i.e. Chhodavdi-Jamwala route and second day i.e. Bhimchas-Hadala route. Together, these two routes yielded 14 scats in 30 km, a scat encounter rate of 0.47/km. A random visual investigation of 22 lion scats revealed hair/remains of chital (59 %), nilgai (18 %), buffalo (14 %), sambar (5 %) and porcupine (4 %).

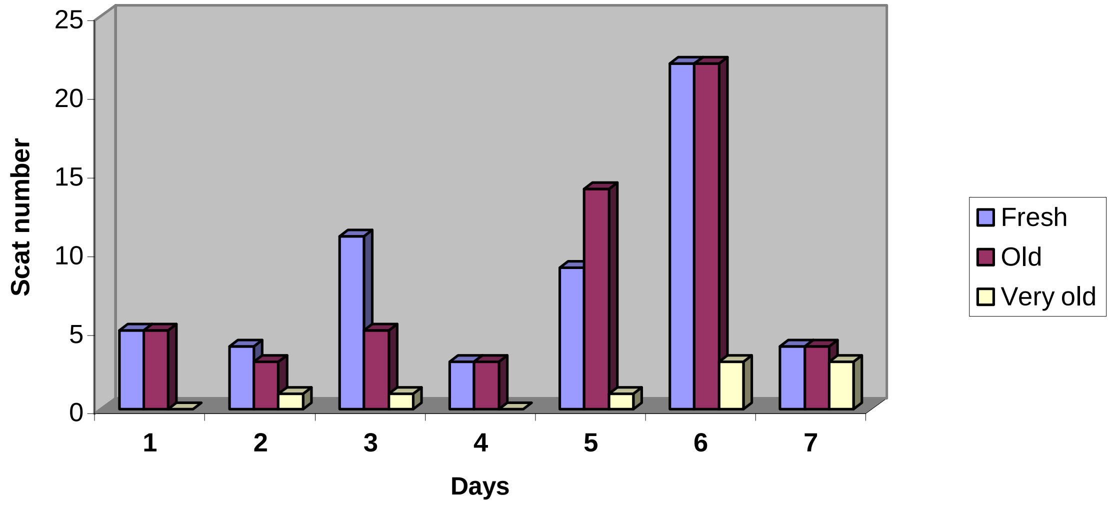


Figure 3. Day wise scat encounter profile of the Asiatic Lion in Gir PA: 8-14 February

Total detections of leopard were a little over one fourth of lion detections. The encounter rate of leopard scats was 0.2/km. Of the six occasions when leopard scrapes were seen, five were along trails. Lion scats were seen mainly on the roads, but these were also encountered on smaller trails inside the forest area, especially in the National Park. On the contrary, most scats of leopard were found on the smaller trails. Scat encounter rate of jungle cat was 0.1/km. Very low number of hyena scat and tracks were encountered despite the high numbers (more than 100 individuals) of this animal reported in the censuses of 1990 and 1995 (Singh 2007).

Prey Species

Among the prey species, occurrences were recorded in the form of sightings and indirect evidences (calls, dung, antler/body rubbings, resting sites, bark feeding and digging).

Table 3. Detections (frequencies) of large prey species in Gir PA: 8-14 February '09

Species	**Call**	**Dung**	**Rubbing**	**Rest-site**	**Bark feeding/ Digging**	**Total (indirect)**	**Sightings**	**Total**
Chital	11	15	10	0	1	**37**	78	**115**
Nilgai	0	83	0	0	0	**83**	5	**88**
Sambar	3	82	14	17	4	**120**	10	**130**
Langur	1	2	0	0	0	**3**	13	**16**
Chousinga	0	8	0	0	0	**8**	0	**8**
Chinkara	0	8	0	0	0	**8**	1	**9**
Wild Pig	0	2	0	0	2	**4**	2	**6**
Livestock*	0	2	0	0	0	**2**	3	**5**
Total	**14**	**192**	**24**	**17**	**7**	**265**	**112**	**377**

* predominantly buffaloes

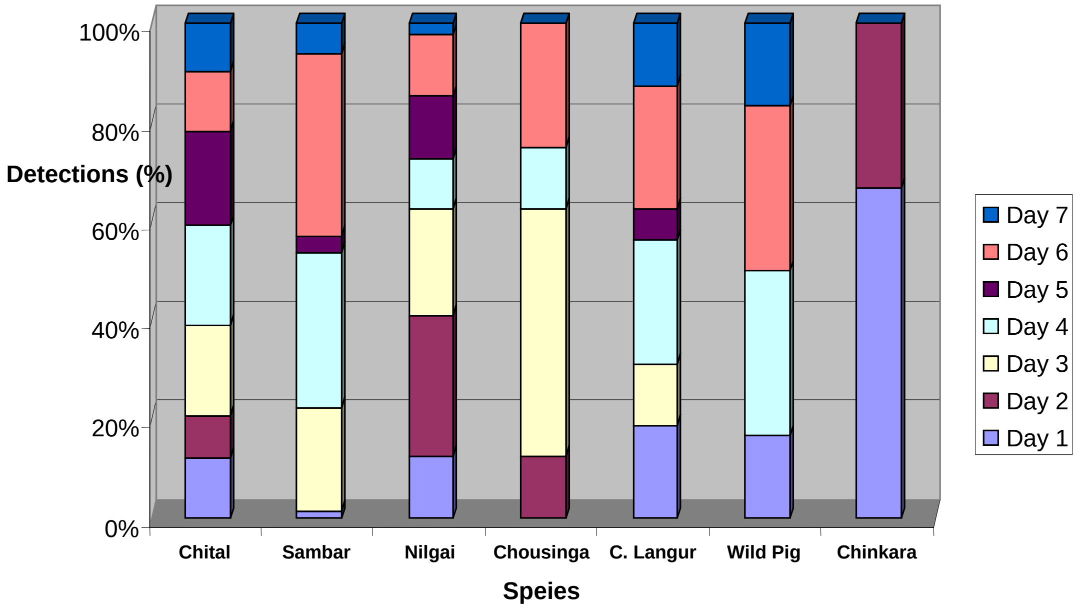
Based on sightings (Table 3 & 4), chital had the highest encounter rate of 0.7/km followed by common langur (0.1/km), sambar (0.1/km), nilgai (0.05/km), livestock (0.03/km), wild pig (0.01/km) and chinkara (0.01/km). No sightings of chousinga were obtained on the foot transect, although twice an individual was sighted while traveling by vehicle. Wild pigs were sighted on four occasions while traveling by vehicle and their total number in these sightings was 23. When indirect evidences were compared, sambar showed highest encounter followed by nilgai, chital, chinkara, chousinga, wild pig, buffalo and common langur (Table 3). The above trend held for numbers sighted with chital showing the highest relative abundance of 60.3 percent, but with one major change being that livestock (buffaloes) contributed highly (22 %) in terms of relative abundance. For other species the order of relative abundance remained more or less similar.

Table 4. Sightings and abundance of large prey species at Gir PA

Species	Frequency of encounter	Encounter rate	Number	Relative abundance (%)
Chital	78	0.71	473	60.8
Sambar	10	0.09	18	2.3
Nilgai	5	0.04	12	1.5
Langur	13	0.12	95	12.2
Chousinga	0	0	0	0
Chinkara	1	0.01	2	0.3
Wild Pig	2	0.02	8	1.1
Livestock	3	0.03	170	21.8
Total	**112**		**778**	**100**

Encounter rates for all detections (sightings and signs combined) were the highest (4.7/km each) on days four and five in and around the NP followed by days six and three (3.5/km and 3.2/km respectively) and day two (3/km).

Figure 4. Daily detection chart of wild prey species at Gir PA: 8-14 February '09



The lowest encounter rates of 2.3/km and 2.4/km were on days one and seven respectively (Figure 4). On the days that we walked in and around the NP yielded higher number of occurrences. Chinkara detections occurred only on the first two days, chousinga and wild pig were recorded only on four of the seven days, while sambar was encountered on five days. Only chital and nilgai were the truly representative prey species of the entire PA being detected on all the seven days of the walk. So, based on the data of this transect, prey species available to lion and leopard in all parts of Gir PA are chital and nilgai.

Lesser Mammals

We encountered or detected through evidence; Indian porcupine, black-naped hare, Indian pangolin, ratel or honey badger and small Indian civet in Gir PA (Table 5). Porcupine was encountered throughout the PA with a majority of its detections (40.5 %) being obtained on day 3 on the Hadala-Chhodavdi trail. The encounter rate of its droppings was 0.34/km. The other lesser mammals showed very low encounter rates.

Table 5. Lesser mammals encountered in Gir PA: 8-14 February, 2009

Species	**Sightings**	**Droppings**	**Tracks**	**Digging/burrows**	**Total**
Indian porcupine	--	31	5	1	**37**
Indian pangolin	--	--	--	1	**1**
Black-naped hare	--	1	2	--	**3**
Ratel	1 (carcass)	--	--	1	**2**
Small Indian civet	--	1	--	--	**1**
Total	**1**	**33**	**7**	**3**	**44**

We specifically asked forest guards to give details of their interesting/unique sightings of smaller mammals. Ratel was reported from both East and West Gir Divisions. In East Gir, three guards reported their sightings, one each of single individual and one of a pair near Bhimchas and Jamwali ness. In the West Gir Division, one forester had seen ratel eight times, mostly in pair around the Khakhrawali beat along Janwadla-Kamleshwar route. In another instance, one ratel was seen by a forester near Kisa ness. We encountered the carcass of a sub-adult ratel killed by a lioness near Khakhrawali beat (*pers. comm.* Rajabhai). The only sure sign of a pangolin was found near Chhodavdi in the form of its burrow. The small Indian civet's presence was deduced based on a single dropping/scat.

Habitat Health and Human Activities

We came across three major human impacts viz. livestock grazing, collection of fuel wood and grass/fodder. Tree cutting was (almost) absent, while a few instances of fuel wood and fodder collection were observed. These appeared mainly for domestic consumption, however, in case of fuel wood collection, head-loads finding commercial outlets cannot be ruled out. Over 170 heads of livestock were encountered at three places and old buffalo dung was seen at a few sites in the Sanctuary. In almost all cases, the livestock (predominantly buffaloes) belonged to the maldhari nesses, or forest settlement village in the vicinity. Severe impacts of heavy livestock grazing such as soil compacting and degradation, weed proliferation were not visible anywhere. We observed higher instances of weed presence in West Gir along the water courses and road sides, especially in the tourism zone between Sasan and Kamleshwar dam. *L. camara* and *Cassia tora* stands were frequently seen in these areas. The latter species is native and naturally forms stands in the herbaceous layer, besides being an important dietary item of Indian peafowl (*Pavo cristatus*) in Gir (Trivedi 1993). In the East Gir, the exotic tree mesquite (*Prosopis chilensis*) was seen at places within the PA, but signs of 'invasion' were not encountered anywhere.

Regeneration of several major tree species was observed throughout. Natural patches of regenerated teak were also observed at one site. Visual assessment of the riverine vegetation along Raval, Shingavda, Ardak and Hiran rivers indicated excellent status of this critical habitat and high use of the same by sambar and chital in most areas. High number of banyan (*Ficus bengalensis*), jujuba (*Zizyphus mauritiana*), silk cotton (*Bombax ceiba*) and flame of the forest (*Butea monosperma*) trees ensures round-the-year food availability to the prey species and thickets of karamda (*Carissa carandus*) provide shade-giving micro-habitats for predators and prey to rest and escape the hot period of the day/season. The National Park (where *nesses* are absent) supports excellent patches of hilly, grassland-savanna habitat. The NP is largely free of human impacts in terms of above discussed human activities. Presence of management interventions such as fire line creation, road maintenance and waterhole management are the major human activities there. Exotic, invasive weeds such as *Lantana camara* are being systematically removed from the National Park area.

Implementation of different wildlife management interventions was observed opportunistically. These included waterhole management, check dam building, fire line creation and road maintenance. All the wells (n>20) within the PA that we saw were covered by grill/lid/mesh with exception of one that was inadequately covered. Waterhole maintenance was properly carried out. Fire line creation was undertaken with sufficient care and executed in time in most cases. In one case, damage to ground nesting birds' eggs was observed. Most roadsides were clear of vegetation and leaf litter to prevent fire, but this practice often needs to be repeated as leaf fall in teak-dominated areas obliterates the clearings. Fire line creation is one of the most daunting management interventions as dry season fires take a heavy toll on the rich grass reserves of the PA every year. 24-hour and day-time watch points/towers at strategic hill-top locations equipped with wireless sets help early detection and dissemination of information. We witnessed very efficient and effective functioning of one such point at *Jada* in the National Park. Provision of about 250 motorbikes has also added to fire management as field staff from far off areas can also reach the affected spots quickly to extinguish forest fires (*pers comm.*, various forest guards). Check dams constructed throughout the PA seem to be retaining water for longer and in greater quantity, but these cement-concrete structures (which also appear out of context and harmony in the riverine areas) need to be monitored to assess their impacts on stream flow and dynamics. Protection of wildlife and the habitat from poaching, illicit cutting and other such acts is carried out by day-time patrolling by guards and by mobile squads throughout. We observed day-and-night patrolling and operations of mobile squad within the PA, especially in the Jamwala and Chhodavdi ranges and talked with concerned staff on duty.

Interactions with Field Staff and Local People

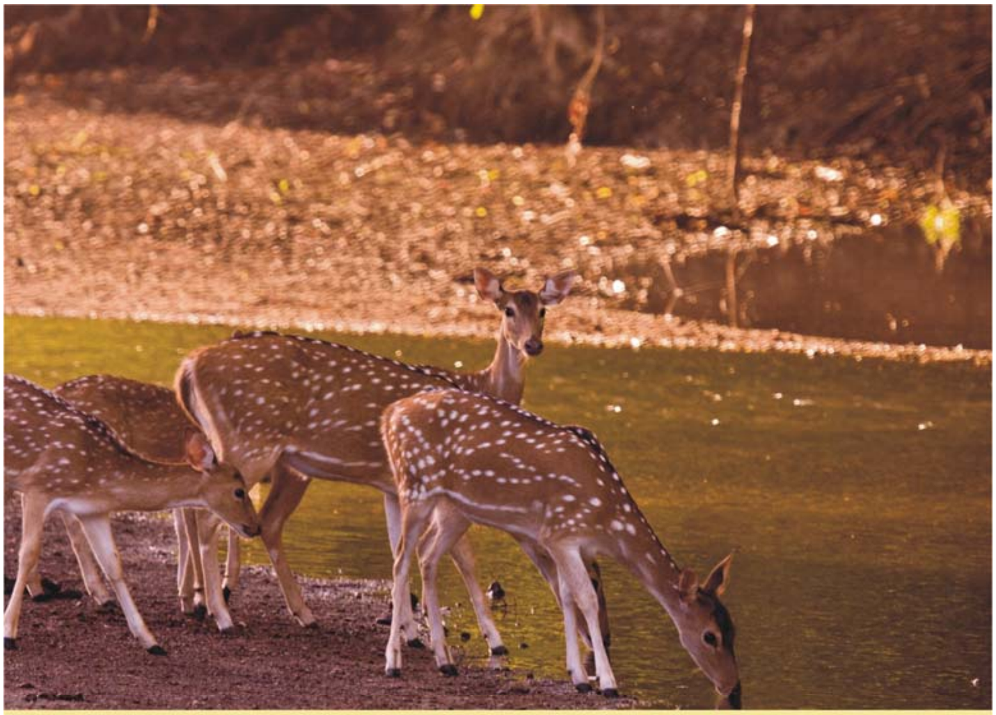
Through informal interviews and conversations that took place during the course of the walk as well as during afternoon breaks; we were able to gather fairly useful information on how the forest department field staff viewed their roles and jobs *vis a vis* the problems they face in field. We interacted with guards and foresters (n=30) ranging from fresh recruits to those who were on the verge of retirement after serving in Gir for over three decades. Various responses to our questions and spontaneous information and feedback from these field staff was very valuable in assessing how the 'protectors' of the lion are faring. Based on discussions with them about wildlife and their problems, it was possible for us to decipher that most of the field staff were proud to be serving in Gir and protecting the pride of Gujarat – the lion.

We found that about 20 % (n=27) of the guards had good knowledge about wildlife (animals and plants) including medicinal uses of plants. Almost similar per cent of field staff were also good interpreters and created engaging and interesting stories around wildlife, their lifestyle and experiences. Several of the newly recruited guards showed eagerness in learning about plants and animals other than lions. Despite this, we come across only a few instances of transfer of knowledge from one generation of guards to another. All the senior guards and foresters were well worse with the forest trails and paths and knew their and neighbouring beats/rounds/ranges etc. quite well. A small percentage of the forest guards had good academic background with Bachelor's degrees and a few were trained teachers (with B.Ed. degrees). These guards felt that their preset job was below their potential, but they were in it due to urgency of earning and/or lack of openings in the rural education sector.

All the field staff were happy about the motorbikes that were given to them recently and several mentioned the usefulness of the 'petrol allowance' being given for the same. Some of the guards pointed out that their beats were a few kilometres away from their quarters and reaching there on foot took a lot of time away from patrolling. This factor is now largely under control as now it is possible for two to three guards to use one motorbike and reach their respective beats easily. The dilapidated status of some forest quarters needs urgent action; a case in point being the quarters at Kamleshwar. On the other hand, there are some old quarters and check-posts (e.g. at *Munda chowk* and near *Batheshwar*), which are still in good shape and can be maintained for temporary posts and patrolling stop-overs. Below listed are some of the ideas and issues which were repeatedly outlined by the guards and foresters, which we believe have relevance with better management of the Gir PA –

- The new recruitment drive has boosted the efforts to protect the lions in Gir PA and provided the much-needed support to overworked field staff.
- Joint patrolling can be very conducive and suitable as it will give them more confidence in tackling the poachers/tree cutters/encroachers and they could do with lack of fire arms.
- In the present scenario, making fire arms available with guards/foresters even on a sharing basis can boost their confidence in patrolling and taking corrective action.
- Proper maintenance and repairing of roads during monsoon to facilitate better transport and communication.
- Need for establishing two/three medical centres spread across Gir PA, equipped with pathology laboratory and resident/traveling doctors to treat high incidences of malaria and diarrhoea during the rainy season.
- Proper facilities in the nearby forest quarters for families of forest staff (schooling, medical and transport) posted in interior areas.
- Regular repair and maintenance of the existing quarters in field, especially from the point of view of water leakage and mosquito-proofing.
- Re-starting a Gir Allowance that was once given to staff posted on field duty in interior locations of Gir PA.
- More backing and support form the higher officials would help them perform far better and risk their lives to protect the Gir forest and its lions.

Our interaction with the *maldharis* was restricted to men herding their livestock inside Gir PA (e.g. *Hadala, Ghudjujwa, Asundrali* and *Dadhiya* nesses) with whom we talked opportunistically. All of them were ‘happy’ to remain inside the PA and find it better compared to rural/urban existence. Some - like the occupants of *Dadhiya* ness expressed that fodder scarcity during summer compels them to undertake migration each year, moving out of Gir during pre-summer to early monsoon.



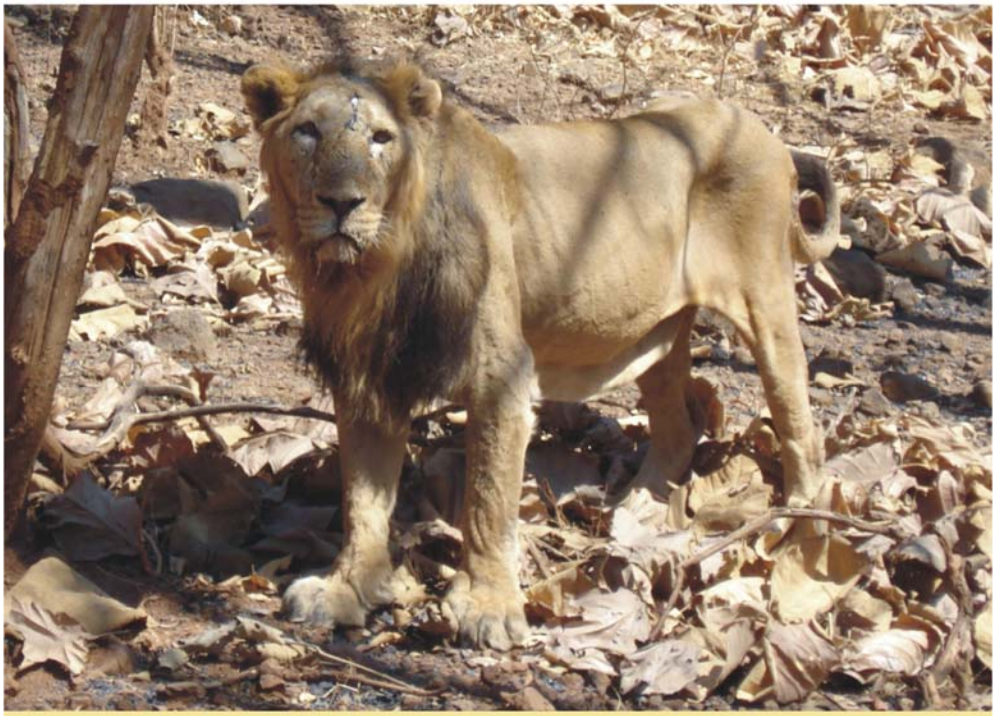
Chital is the most commonly encountered prey species at Gir

Sambar - largest wild prey species at Gir

Striped Hyena - a vulnerable scavenger?

Jungle cat, a common lesser cat species at Gir

Big antlers of sambar and chital are a common site in stream beds



The oldest lion encountered during present survey

DISCUSSION

Background and Limitations

The 110 km long foot-transect across the length of Gir PA traversing through a majority of vegetation types and terrains provided a representative cross section of the Gir ecosystem. Using both, existing jungle roads and trails provided a window to peep into the world of the lion and assess its conservation status in light of habitat health, prey species and anthropogenic influences including various management practices. Walking offered the possibility of exploring and investigating well compared to other methods of surveying. As a result, we often wandered into the forest up to two kilometres (sometimes more) on both sides of the road/path when something interesting was encountered or when the accompanying staff suggested us to investigate or explore. The high encounter rate of mammals in general and detections of 17 species was indicative of the high mammal diversity of Gir PA. Before we discuss the findings of this rapid reconnaissance and their relevance for lion conservation, we would like to outline the major limitations of this reconnaissance. First, we did not cover the entire Gir PA and the picture that our survey route provides needs to be treated as a pilot or a sample and only for the area that we covered. Second, walking along existing roads has its advantages and disadvantages compared to a vehicular transect, or walk through the forest interior on trails. This factor could have contributed to lower detections of wary ungulates such as four-horned antelope and cryptic carnivores such as leopard and lesser predators. Third, traveling only during the day light hours meant that some of the ungulates such as nilgai and wild pig were not sighted frequently due to their crepuscular/nocturnal activity patterns. With this background, we now look at the results and discuss their implications on assessment of the status of lion conservation in Gir PA.

Carnivores

The census figures of 1974, 1979, 1985 and 1990 for Gir PA indicate that lion was the most abundant predator followed by leopard and hyena; a trend that showed a change in 1995 and 2001 censuses where leopard numbers were higher than lion, but hyena remained the lowest of the three (Singh 2007). The 2005 census did not include leopard and hyena. Our results show a similar trend, especially for scat encounter rate of carnivores.

Lion group size based on sightings agrees with Meena (2008) who gave an average group size of 1.4 and 1.3 for males and females (without cubs) respectively. Singh (2007) mentioned average group size to be of four in 1990, which was reduced to three to four during 1995. Ranjitsinh (1997 in Divyabhanusinh 2008) also referred to a reduction in average pride size after stoppage of baiting in 1988. Higher number of livestock due to higher density of *maldhari nesses* in East Gir compared to West Gir now seems to be leading to higher group/pride sizes there as noted by Singh (2007). We did not come across any pride, but the only pride (consisting of seven animals based on information given by local *maldhari*) was encountered in East Gir and the number of lions in a frequently met with pride in West Gir (*pers comm.*, forest guards) seems to be six animals.

Sightings and calls were not adequate for us to conclude about lion's presence in and use of different parts of the Gir PA. Scats, however, provided a useful indice to dwell on this topic though considering only larger sized scats (>45 mm) excluded cubs less than one year old (Joslin 1984). Our rough classification of fresh, old and very old scats indicated very low incidence in the last category i.e. very old. This could be due to disintegration and destruction of scats beyond a certain period. Joslin (1984) suggested 6.7 days on an average for destruction/disintegration of scats. In the NP area, where largely physical environmental factors operate, it may take much longer for the scat to disintegrate compared to Sanctuary where livestock and vehicle movement is much higher. The only attempt made earlier to estimate lion abundance trends from scats was by Joslin (1984) who gave an encounter rate of one scat per 6.4 km. We recorded one scat per km in the present survey. When we considered only fresh scats, the encounter rate was 0.53/km, or roughly one scat per two km. This was still three times higher encounter than showed by Joslin. This is undoubtedly an indication of change in lion abundance and improvement in its conservation status since Joslin's work in early 1970s. The census figures are also suggestive of this trend.

The day wise encounter indicated very high movement and use of Jamwala-Janwadla-Kamleshwar region by lions in Gir PA. High use of the NP- Sanctuary edge in this region (which apparently boasted the highest ever male coalition of seven individuals during late

1980s, Ravi Chellam, *pers comm.*) was noteworthy and probably indicated several overlapping home ranges or some other habitat-based or prey-based (or both) advantages. This also highlights the importance of the NP in conservation of lions. Chhodavdi and Jamwala ranges support high densities of ungulates (>50/km^2) and Sasan range has moderate (30-50/km^2) ungulate densities (Singh 2007). Besides, the Janwadla forest block has high chital and sambar numbers (Singh 2007). Higher concentration and abundance of these prey species could be important factors contributing to higher lion occurrence in the area.

The low scat encounter rate on the fourth day could be largely owing to walking on smaller forest trails and the State Highway that passes via Chhodavdi and Jamwala. The latter route has much vehicular traffic and disturbance and though we did see pugmarks of a few leopards and lions, lion scats were not seen here. It is indeed difficult to explain the low scat encounter rate on the second day, especially as the area has moderate ungulate density of 30 to 50 per km^2 (Singh 2007). However, when the presence of a pride at *Asundrali ness* (which we only heard and recorded as indirect evidence) is also taken into account, the picture improves considerably. The last census (2005) showed about 60 per cent lion population in West Gir and the remaining 40 per cent in East Gir (Singh 2007). Our results show a much lower percentage of the number of scats encountered in East Gir when overall numbers (24 % of all the scats found) or only fresh scats (26 % of total fresh scats) were considered. West Gir showed three times higher number of scats. However, when scat encounter rates for East Gir and West Gir (0.7/km and 1.4/km respectively) were considered, West Gir showed double the rate of scat encounter than East Gir. It is known through earlier censuses that East Gir has fewer lions, but not half or even lesser than that as shown by the scat numbers encountered on our transect. This could partly be due to less coverage of roads and higher use of smaller trails in the hilly, interior forest areas in East Gir. Chital appeared to be the most frequently consumed prey species followed by nilgai, buffalo and sambar; more or less taken in order of their abundance. This finding of course is nothing more than a crude sample of the existing pattern of lion's predation along our survey route in Gir PA.

Low detection of leopard was intriguing as based on the last three censuses (except 2005 when leopards were not censused) leopard number was almost similar or a bit higher than lion number in Gir (Singh 2007). Lions are known to kill leopards (Dharmakumarsinhji and Wynter-Blyth 1950 in Divyabhanusinh 2008) and appropriate their kills in Gir. Extensive use of roads in the present survey also highly used by lions could have influenced the detection probability of leopard. Very low encounter of hyena signs was difficult to explain. Hyenas too are known to travel on roads like lions and missing their tracks and characteristic scat was unlikely. It is possible that their defecation rate may be less. Since hyena has not been included in the census for almost the past decade, it needs to be seen how it is faring. Very low encounter of jackal throughout the survey is a matter of concern. This animal which was once fairly common (*pers. observation*) and seen throughout Gir, but partial to fringe villages (Singh 2007) could have been affected by use of pesticides to poison crop-damaging animals such as wild pig (Ranjitsinh 1997 in Divyabhanusinh 2008) and nilgai as has been observed in some rural landscapes of Gujarat (Kandarp Kathju, *pers comm.*). Road kills by ever increasing vehicular traffic around and within Gir also seem to be a likely factor to affect both hyena and jackal populations (Singh 2007). It is pertinent to point out over here that we had only one sighting of vultures in 110 km walk (red-headed or king vultures) – quite unusual for a PA, where Grubh (1973) reported six species of vultures, often in good numbers on carcasses. Their decline has been noticed and reported (Singh 2007, B. J. Pathak, *pers comm.*), but what we observed could be termed alarming. Feeding on livestock kills made by lions and leopards on the outskirts of PA and even within it could have caused Diclofenac induced mortality. This possible steep decline, to a greater or lesser degree of both avian and mammalian scavengers of Gir ecosystem should be a cause of concern and worth investigating.

Prey Species

Wild and domestic ungulates form the bulk of lion's diet in Gir PA, hence monitoring their abundance and distribution can be of immense help in assessing the conservation status of the lion and health of the habitat. For prey species; the earlier censuses from 1990 to 2005 showed a clear trend of chital, common langur, sambar, wild pig, nilgai, chinkara/chousinga in the decreasing order of abundance in Gir PA (Singh 2007). Similar trend of prey detection/abundance was observed during our survey. Preponderance of sambar detections was brought about by a high number of pellet groups encountered along riverine habitats. Chital, common langur and wild pig were detected more frequently by sightings than sambar, nilgai, chousinga and chinkara which were better recorded by droppings/pellet groups (see Figure 3). Our sample is not very large, but the trends indicate that a method based on recording sightings alone may not work as activity patterns of different prey species vary, so also their use of areas near roads. Also, previous studies have not provided encounter rates of these species to compare with. Vehicular transects could be more useful in this case. Highest detections were obtained on days - six, four and three (in this order). These corresponded to Janwadla-Kamleshwar, Chhodavdi-Jamwala and Hadala-Chhodavdi routes respectively. It wasn't thus a co-incidence that we recorded the highest number of lion scats on day six along the Janwadla-Kamleshwar route. It seems that high wild prey availability, especially sambar could have given rise to higher detection of lion scats here.

Chital, nilgai and common langur were encountered more or less throughout on the foot transect; while sambar, chousinga, chinkara and wild pig showed patchy patterns of encounter. Sambar and chousinga appeared partial to hilly and less disturbed tracts compared to chital and nilgai which were encountered almost throughout, barring the seventh day. Chinkara sightings and signs were found only in East Gir, an area of savanna, thorn-scrub and grassland, where nilgai presence was also higher. Sambar presence was much higher in the West Gir region with hilly terrain and denser forest. The lowest encounter of wild prey was in the tourism zone (Sasan to Kamleshwar). Domestic livestock had a low encounter, but owing to high numbers and biomass, it occupies a position only next to that of chital in terms of prey availability for the lion.

Lesser Mammals

Gir PA is a stronghold of several species of threatened lesser mammals such as the rusty-spotted cat (*Felis rubiginosus*), ratel and Indian pangolin. The contiguous dry deciduous forests, savanna and thorn-scrub habitats of Gir PA provide suitable niches for many smaller mammals. The encounter rate of porcupine droppings is an indication of this. Several droppings were of large size and indicated occurrence of adult animals that can provide buffer prey for leopard and occasionally for lion (Singh 2007, *present survey*). Occurrence of ratel in various parts of Gir was confirmed through the present survey through interaction with forest guards.

Habitat Health and Human Activities

Good habitat quality in Gir was reflected through copious regeneration of major tree species, luxuriant riverine vegetation along all the major river courses (except some stretches along the Hiran river in the tourism zone), low (or no) weed infestation, near absence of illicit tree cutting, protection of habitat through patrolling and various other management practices and abundance of wild ungulates. High occurrence of plant species such as *F. bengalensis*, *Z. mauritiana* and *C. carandus* play key roles by providing important habitat requirements of lions and other wildlife (Fenton 1924, Dharmakumarsinhji and Wynter-Blyth 1950; both in Divyabhanusinh 2008). The practice of controlled extraction of grass for fodder seems to be very useful for habitat management as very dense and tall grass is unpalatable for wildlife, creates fire hazard and prevents fresh growth (Sharma and Johnsingh 1996). Livestock grazing at the present extent has not caused competition induced changes in the dominant wild prey – chital's population (Dave 2008). Occurrence of chital and other wild prey in fair abundance coupled with their low flight distances (*pers. observation*) is a reiteration of the health of habitat in terms of good forage availability and lack of persecution from humans. Round-the-year water availability in western, central, southern and eastern parts of the PA (excepting northern portions and the Chachai-Pania Sanctuary) further enhances carrying capacity of the habitat. The present extent of fuel wood removal by *maldharis* and people of neighbouring villages needs to be quantified and monitored for preventing commercial use of this resource.

Management interventions such as fire prevention/controlled burning, waterhole management and soil-moisture conservation activities (check dam construction) are showing positive impact through improving habitat quality and preventing degradation.

By placing waterholes within or besides existing water courses and spacing these out evenly (Sharma and Johnsingh 1996), crowding of herbivores and subsequent degradation of the surrounding habitat will be prevented. Patrolling of the PA and surrounding areas is crucial for protection after the trapping and poaching incidents in 2005 and 2007 which resulted in casualties of lions in Gir PA (Singh 2007). Whereas the role and impact of mobile squads is clear and important, day-time patrolling by guards is even more crucial as changes in habitat and wildlife *vis a vis* human activities can only be detected and reported better through this intervention. A special cadre of informers (who are preferably local community members) could be created who move in the villages to gather evidence and information about illegal activities concerning wildlife. Harnessing both, the experience and knack of the senior guards and the energy and enthusiasm of the fresh recruits as well as regular assessment by the higher authorities of the Gir PA could help achieve this in a more effective manner.

High occurrence of lions and their prey along the NP - Sanctuary edge and in NP area as shown by scat encounter rates during this survey dispels the issue of unsuitability of the NP for the lion due to dense habitat. Besides, several reports of the past clearly mention Gir as a dense/thick forest (see Edwards and Fraser 1907, Fenton 1924 and Wynter-Blyth 1949; all in Divyabhanusinh 2008), where lions have shown a consistent and encouraging increase in population over the last four decades. Long stretches of rivers *Ardak*, *Bhuvatirth*, *Shingavda* and *Dhatardi* within the NP have pristine gallery forests that provide shade and shelter to the lions (Ravi Chellam 1997 in Divyabhanusinh 2008) and wild ungulates during the hot days/summer. Owing to healthy habitat conditions, a high proportion of all the wild prey species of lion (except chinkara) was recorded in the NP. Moderate to high abundance of sambar and chital in Chhodavdi and Jamwala ranges (Singh 2007) reflects excellent habitat conditions for lion and leopard. Invasion of the exotic *Lantana camara* has also been controlled effectively and regular removal has helped prevent further damage to the habitat. All the above factors coupled with a near lack of human impacts make the NP an undisturbed stretch of quality habitat for lion and its prey.

Interactions with Field Staff and Local People

Based on the informal discussions with and observations of the forest department field staff, we submit that there is a need to -

- Motivate the guards by organizing refresher courses.
- Inspire them with stories of guards having achieved amazing feats in other PAs of India. This can also be done by study tours and/or screening of films during the motivation workshops
- Present rewards and opportunities for interaction with non-forest dept. agencies and individuals of repute in the field of environment.
- Facilitate interaction and learning between old and new field staff by organizing pair/team patrolling at least once/twice a month, field skill workshops. This will help the old in increasing self-esteem and pride, while for new staff it'll be valuable learning.
- Promote interaction with good naturalists and facilitate nature interpretation and observation skills.
- Facilitate greater positive and synergistic interaction within the field staff and between them and higher officials. This will aid in facilitating improvement of their self-image, leadership and teamwork and making them stake holders.
- Promote periodic visits of higher officers for grievance redressal, encouragement and being familiar with field problems.
- Provide hygienic living conditions and healthcare for them and their families.
- There is very little involvement of the *maldhari* populace in protection and management of the PA. We saw a marginal role played by them as daily wage workers, but a larger stake in protecting and improving the habitat and soliciting voluntary involvement could be of relevance in the long-term. A lifestyle and culture that has evolved out of tolerance and mutual respect between humans and wildlife will thus be conserved.
- Awareness generation among students is being carried out through nature education camps, however, greater involvement of rural youth in protection and monitoring as well as eco-tourism will be important to help in conserving Gir and its wildlife.

Suggestions

Our aim in this reconnaissance was to use several means of presence detection to facilitate the identification of one tool that achieves several outcomes including monitoring of lion and its prey. Such a method can then be used for regular monitoring in future in a cost-effective and relevant manner. Further, our aim was to look at the habitat health *vis a vis* human activities to help assess the conservation status of lion. The following suggestions could be useful guidelines –

- Our method of using foot transect across the length of Gir PA was effective in yielding baseline for regular implementation of such a monitoring exercise.
- Using the same transect for lion and its prey species will be very useful and using roads for this purpose will be advisable. However, vehicular transects could be better suited for higher detection of prey species.
- It is clear that for carnivores, scat was a useful indicator of their occurrence and abundance; while for the prey species, direct sightings were more useful. Sightings of carnivores and dung/pellet group encounter rate methods for these can be used respectively in addition.
- Lion monitoring by scat-encounter could be preceded by removal of all old scats on day-1 and then survey should be made on day-8 after leaving a gap from day-2 to day-7. This will help ensure that only freshly deposited scat is considered and double counting is avoided. This can yield an index of lion abundance that would help in comparing habitat use by lions between different regions of Gir PA.
- Two routes running parallel across northern and southern portions could be used for this purpose. About 200 to 250 km would be covered in this monitoring.
- The status and health of habitat in Gir PA is good and management activities were implemented properly and effectively.
- Regular patrolling, photo monitoring by guards and motivation to record and write observations in field could help lion conservation in a tremendous way. The Gir Welfare Fund (GWF) can bring out a quarterly newsletter or an annual souvenir (edited and produced by field staff), where such observations are published.

- As the ‘tourism zone’ in Sasan-Kamleshwar zone showed the lowest encounter rates of ungulates and lion detection; but higher signs of disturbance including weed infestation and riverine habitat degradation; this zone could be monitored to assess the impacts of tourism. On the other hand, one of the routes could be rested for a year or two from the tourist circuits on a rotational basis to allow its recuperation.
- Roads, especially the state highways with a high number of vehicles were found to be a detrimental factor for wildlife. Hence it is important to curb night traffic on all the roads passing through Gir PA in the light of high conservation status and priority accorded to the lion.

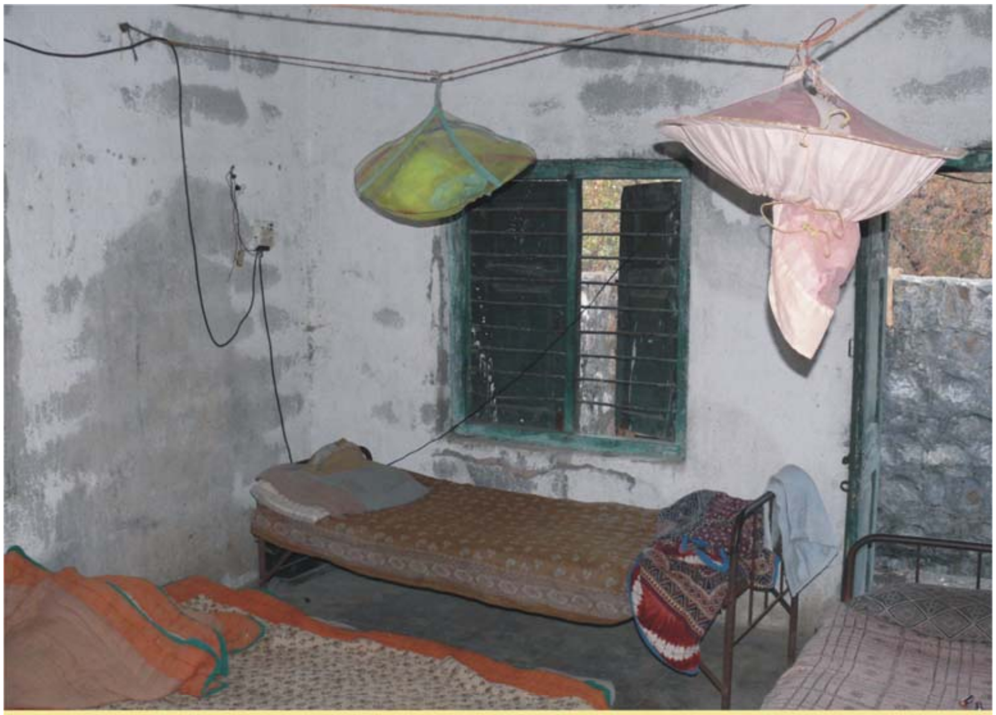
From the foregoing it is clear that habitat health in Gir PA is good and supports high diversity of prey species. Proper and adequate management interventions and protection measures post-poaching incidences have ensured a safe haven for the lion. The scat detections and other evidences suggest that the conservation status of lion in Gir PA is good. We would like to reiterate that long-term monitoring by a standard method would help strengthen this further and prevent damage in future. Our reconnaissance has provided a potential option to achieve this in a relatively cost-effective and rapid manner. If two such routes passing across the Gir PA are monitored simultaneously each year, or every two years, useful results can be obtained. The scats can be collected and sent for DNA analysis every five years to aid in individual identification of lions. It may be pertinent to mention here that this monitoring is not to replace the existing census, or other suggested methods of population count; but to facilitate annual and rapid monitoring of lion, its prey and habitat health. Credible research institutions can be involved as partners for the first phase (five years), during which the field staff can be trained. The monitoring can also be made more transparent by involving the members of civil society and NGOs. This will doubtlessly get more friends for Gir and contribute to better conservation of the Asiatic lion.

Interactions with *maldharis*

Discussions with field staff of the Forest Department

Check dams - useful, but their impact on stream dynamics not well studied

A roadside clearing for fire prevention



Staff quarters in need of repair

Maintenance is the most challenging operation inside the PA

The proud possession - recent and valuable

Riverine forests such as this are the lifeline of Gir

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"No other wild mammal on the
Indian subcontinent.....has had such a man-caused
impact upon its daily life, food habits and behaviour as
the lion. Few animals have hovered so long between
survival and extinction."

- *M. K. Ranjitsinh*